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the ROYAL COMMISSION on the NORTHERN ENVIRONMENT

A FEASIBILITY STUDY FOR
METHANOL PRODUCTION IN
NORTHERN ONTARIO

Funding Program Report

ROYAL COMMISSION ON THE NORTHERN ENVIRONMENT

J.E.J. FAHLGREN, COMMISSIONER

A FEASIBILITY STUDY FOR METHANOL PRODUCTION IN NORTHERN ONTARIO

by

Energy Probe

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April 1979

Energy Probe began as the Energy and Resources Team of Pollution Probe at the University of Toronto. In 1975, it became a seperate organization working to ensure that longer term solutions to out energy problems are being formulated and pursued. Energy Probe is a non-profit project of the Pollution Probe Foundation.

The preparation of this report was made possible by a grant from the Royal Commission on the Northern Environment. We express our gratitude for their support.

The authors would like to thank Jan Marmorek, Judy Smith, Chris Conway and Robert Gibson for their assistance during the preparation of the report.

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INTRODUCTION

Energy policy has only recently been recognized as something more than simply a means of delivering energy. It is now generally accepted that different energy policies offer varying contributions to patterns of regional social and economic development. However, although agreement may exist on the breadth of impacts, debate continues both on the definition of social and economic goals, and on the most appropriate means of achieving them.

It is within this highly uncertain and evolving context that the Royal Commission on the Northern Environment will make its recommendations concerning the future of Northern Ontario; a future that will inevitably be tied to northern energy consumption and development. An appreciation of energy opportunities in the north and of their impacts is an important preliminary step in deciding directions for development in Northern Ontario.

The link between energy supply and demand and regional development is a two way relationship. In the first case, decisions about industrial and resource development, population growth, etc., serve to define a range of plausible energy supply and demand options. A commitment to improve local manufacturing and increase local population, represents a commitment to increase energy consumption. In the second case, and more important from a policy perspective, specific energy supply and demand decisions can help to direct or encourage particular types of development. Thus, whether energy policies are seen as <u>products</u> or as <u>instruments</u> of regional planning, they must be examined in light of their social, economic and environmental implications.

All energy technologies are not created equal. For example, the employment

spinoffs of some energy supply projects differ by a factor of eight or more. Because energy projects differ in scale by many orders of magnitude, they are subject to varying degrees of local political and public control. Because energy developments differ in their physical resource requirements, they also vary in terms of their environmental effects.

Perhaps most important, energy supplies differ in the efficiency with which they can fulfill different end use needs. Energy consumption can be divided into different categories on the basis of the "thermodynamic quality" of the tasks to be performed. For example, energy demand in 1974 in Ontario was as follows:

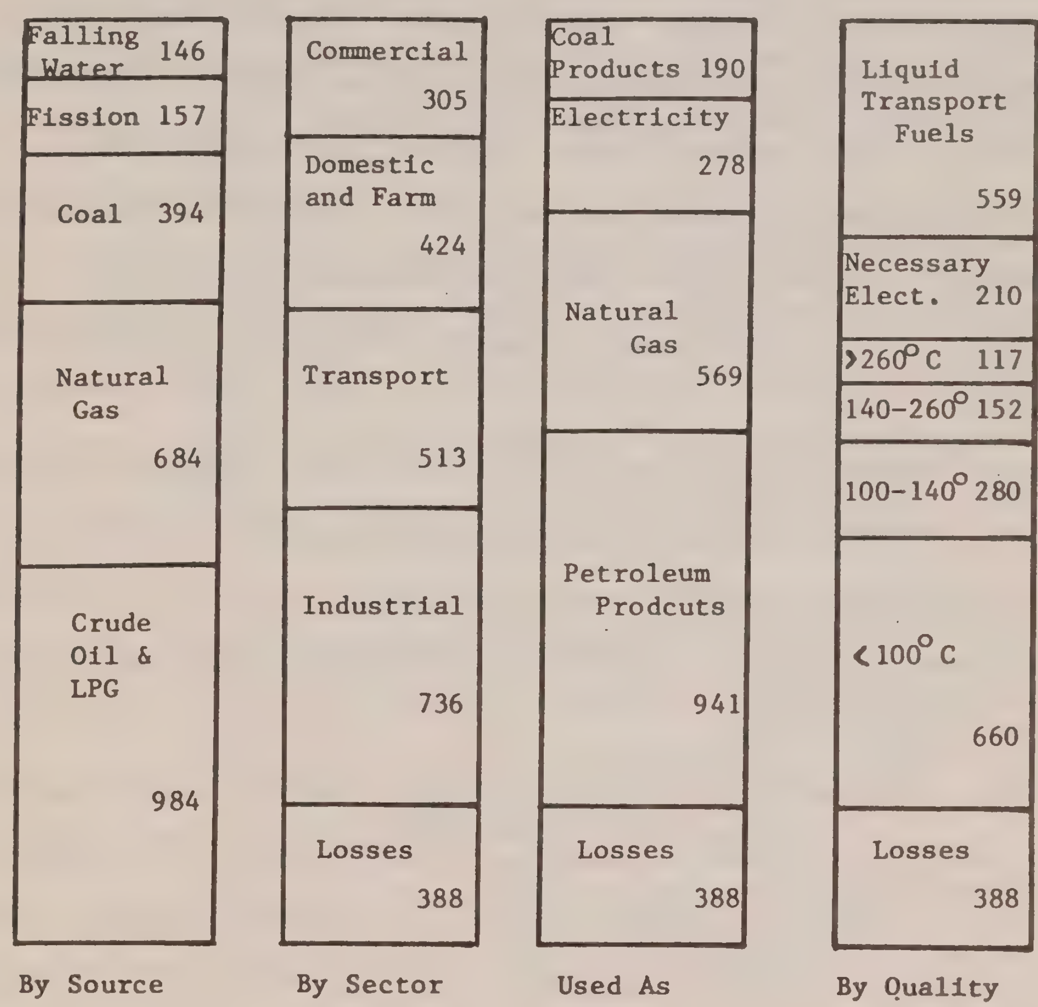
a) heat at less than 100°C	33.4%
b) heat at 100°C - 140°C	14.2%
c) heat at 140°C - 260°C	7.7%
d) heat at more than 260°C	5.9%
e) liquid transport fuels	28.3%
f) necessary electricity	10.6%
Total	100.0%

In general, the most efficient energy system is one which matches the energy source to the "quality" of the end use to be performed.

As can be seen from the accompanying chart (next page), Ontario is now heavily dependent on oil, natural gas, coal and some electricity for our energy needs. However, as oil and gas become scarce and as costs continue to rise, Ontario will have to respond by modifying its energy consumption. The easiest and cheapest response to our energy supply problems is conservation and increased energy efficiency. Energy Probe has calculated that energy demand need grow at no more than 0.6% per year, with improved efficiency and minor lifestyle changes, and other studies have also indicated that the room for efficiency improvements is large.

Ontario Energy Use in 1974

(in Btu x 10^{12})



In the long run, however, oil and gas supply will be limited, and meeting our energy needs will require a choice between more thermal electricity (coal and nuclear) or a transition to reliance on renewable energy. Nearly half our energy requirements are for low temperature heat, and applications of solar technology will almost certainly emerge as economically, environmentally and social preferable to the more risky and wasteful thermal electric option.

Regarding the prospects for electrification of the transportation sector, there are several major concerns. Some, including the technical problems associated with designing electric cars and "fuel" distribution systems, seem to be surmountable. Others, particularly the financial, environmental and social problems arising from a massive expansion of electrical generation, seem more difficult.

The costs of retrofitting the current stock of internal combustion engines to accommodate methanol, would be large, but insignificant in comparison to the capital expenditures needed to provide an additional 2.6 Quads (10^{15} BTU) of electrical energy by 1990. In 1977 dollars the capital requirement would be approximately $275 billion.

In addition, there would be serious environmental repercussions, regardless of whether the electricity were to be generated by burning coal or oil, splitting uranium atoms, or diverting and damming rivers. All present problems, ranging from the evident despoilation of strip mining and flooding rich valley lands, to the unseen hazards of low-level radiation, the threat of unpleasant climatic changes resulting from further increases in atmospheric carbon dioxide levels, and the legacy of inadequately stored nuclear wastes.

There is also reason for concern about the social implications of increased centralization of energy sources, disruption of outlying communities and dislocation of native people, accidents with unacceptable consequences at nuclear power plants, and further growth of public sector energy monopolies and bureaucracies.

In light of the negative aspects of transport system electrification, the renewable liquid fuel option seems extremely attractive. Its technolgies are viable; its feedstock is renewable and sustainable; and it promises significant socio-economic benefits.

There is an urgency associated with finding alternatives to run our liquid fuel-based transportation sector. Global oil proudction will likely peak before the end of this century and prices will rise dramatically even sooner. This report, which considers the potential for developing a methanol industry in Ontario based on forest biomass, should be considered in the context of this urgency.

We begin by discussing the technical aspects of methanol production technology, and the potential size of the biomass resource base from northern Ontario forests. This is followed by a discussion of the forest management implications of the development of a demand for forest biomass energy.

Finally, and most importantly, we turn our attention to the question of whether a methanol industry based on the forest biomass of the northern forest regions (NorthWestern, North Central, Northern, North Eastern) -- which we believe to be technically feasible and potentially acceptable ecologically -- can be developed in harmony with northern development objectives, as defined

by northerners. Clearly, this last question can only be answered by northerners themselves. By way of this report, we are only attempting to propose one potential component of a northern development strategy, and discuss its relative merits.

METHANOL PRODUCTION AND UTILIZATION

Methanol is currently manufactured employing natural gas as the primary feedstock. Research and development of processes employing coal, lignite, municipal solid wastes and wood residues is currently being undertaken in North America. Regardless of the feedstock employed, the physical properties of methanol (CH_3OH_1 methyl alcohol) are constant. The most thorough analysis of this liquid fuel in Canada has been conducted by D. Mackay and R. Sutherland of the Dept. of Chemical Engineering and Applied Chemistry at the University of Toronto. A detailed analysis of the physical properties of methanol as prepared by them is included in the appendix.

Methanol is employed currently as an industrial chemical in the production of formaldehyde which in turn has many industrial uses. Methanol has also been employed as an anti-freeze, a solvent and has seen increased use in the petro-chemical industry.[1]

The use of methanol as a fuel is in the developmental stages, although several test fleets throughout the world have been operated employing the fuel either in a blend with gasoline or by itself. Aggressive research into the use of methanol as a liquid fuel, petroleum substitute is currently underway in Sweden, West Germany, and in the United States.[2] Enthusiasm for the introduction of methanol fuels in Canada has been more subdued than elsewhere, a fact which is probably attributable to Canada's historic supply security. As we move closer to a shortfall of domestic energy, interest in methanol should increase.

Primary interest in the use of methanol as a liquid fuel has been directed towards the needs of Canada's transport sector. Similarly, this report

1. Mackay, Sutherland, Methanol in Ontario, Ontario Ministry of Energy, 1976.
2. Swedish Methanol Corp., Volkswagon, Solar Energy Research Institute.

focusses on the use of renewable resource-based methanol as a liquid transport fuel and an examination of the benefits and limitations of methanol as a petroleum substitute will be conducted. Although preferred value is shown for the use of methanol as a transport fuel, it could also be employed as a fuel for home heating and in certain applications, as fuel for gas turbines and boilers.

As a fuel for domestic heating methanol would have a preferred use in several instances. As documented by A.C. Hayden of the Canadian Combustion Research Laboratory of EM&R, the efficiency of conventional oil burners can be increased when burning methanol with a retrofitted retention head[1], especially in those houses where the conventional boiler is oversized in its original installation or because of any upgrading of the insulation in the house. The use of methanol as a fuel for domestic heating would require several alterations of the fuel heating system to guard against the infiltration of water into the methanol. Several additional precautions would be required to ensure the safe operation of heating systems employing methanol.[2]

In a report prepared by Energy and Environmental Studies Department of Ontario Hydro[3], the use of methanol as fuel for use in gas turbines was highly regarded. Although the report suggested that the economics of methanol use were restrictive, it did suggest that from the perspective of efficiency, emissions and ease and reliability of operations, methanol was an attractive fuel option.

Physical Properties

Several technical restrictions are encountered when considering the use of

1. A.C. Hayden, Utility of Methanol
2. Ibid.
3. --, Utilization of Synthetic Liquid Fuels for Electric Generation, Energy & Environmental Studies of Ontario Hydro.

methanol as a transport fuel. The major problems which must be addressed have to do with its distribution, storage and use as a blended fuel with gasoline. Many of the problems associated with these blend fuels do not occur when methanol is burned by itself, a factor which should be taken into account when considering vehicle design in the future.

Substantial testing of automobiles burning blended fuels (methanol-gasoline) has been carried out over the last several years.[1] Conventional testing involved monitoring driveability, fuel economy, pollutant emissions, tolerance to water and corrosion characteristics. Although some difficulties with cold starting, corrosion and phase separation caused by water contamination of the methanol/gasoline blends have been reported, most authors suggest that minor modifications to the existing automobile stock would alleviate problems associated with blends of up to 30% methanol. Test results employing blends of less than 10% methanol demonstrate no serious adverse results when used in existing automobiles. For a thorough analysis of the various tests which have been undertaken, read Vol. 5 of the Report of the Advisory Group on Synthetic Liquid Fuels of the Ministry of Energy[2].

Several beneficial aspects of methanol/gasoline blends exist. Reduced emissions of carbon monoxides, hydrocarbons and nitrous oxides were recorded in most of the studies perpared to date. In some cases the CO emissions were 40 - 50% less with blended fuels although decreased emissions of NO_x and HC were not quite so substantial. Improvements in energy efficiency can be realized in vehicles employing methanol fuels (in blends or straight) on

1. Shell Oil, Volkswagon, Texaco, Swedish Methanol Development Co., T. Reed.
2. Utilization of Methanol-Based Fuels in Transportation, Ministry of Transportation and Communications, 1978.

account of the higher octane number of the fuel. For new vehicles designed to burn methanol these improvements miiht amount to 30%.

For new vehicles, several design alternatives have been employed to maximize the use of methanol fuels. Dual fuel systems, fuel injection, electronic ignition and the incorporation of components less prone to methanol's corrosive characteristics have been tested successfully. Indeed, Elliot in Utilization of Methanol-Based Fuels in Transportation, makes a persuasive case for completely staying out of the market of retrofitting the existing automobile stock to burn blended fuels. He points to the median age of vehicles in Ontario, which is about six years. At a turnover rate of this order, by 1984 almost half of the vehicles on the road will be post 1979 models. If we assume a three year lag time for retooling specific engine components in the automobile manfuacturing industry, newly designed vehicles burning blended or "neat" methanol fuels could be introduced in the early 1980's. It appears that the automobile stock can be upgraded to burn methanol fuels even before the fuels are available in sufficient quantities. Implementation strategies will need to take this factor into account.

Several supply and utilization options are available as means of implementing methanol fuels in an orderly fashion. Small amounts of methanol can initially be blended with gasoline and distributed in a conventional manner. These small fuel inputs (up to 5% blends) could be mixed either at the refinery, or in some cases directly at the pumps. This option, while avoiding any of the technical problems associated with storage and distribution,[1] does not afford the opportunity

1. R.M. Tillman,"Blending, Distribution and Storage of Alcohol Fuels", 1976.

of significant displacement of petroleum fuels. More significant savings of our non-renewable petroleum resources will result from blended fuels containing between 15 - 20% methanol, but correspondingly, the problems associated with storage distribution and usage multiply. Some of the performance difficulties have already been briefly mentioned and can be resolved by the automobile manufacturers at no great additional expense to the purchaser. New engines designed to withstand the corrosive nature of methanol and eliminate phase separation problems can be produced at costs only slightly above current prices ($50 -100 per car).

The mose imposing problems associated with the higher blends of methanol have to do with the distribution and storage of the fuel. Because of phase separation difficulties methanol would have to be stored in separate tanks from the gasoline. These tanks would need to be impermeable as water must be excluded from gasoline-alcohol blends. Distribution at the pumps could occur in the same manner as occurs at Sunoco, where two separate fuels are blended at the pump. All of these changes will necessitate substantial capital outlays to pay for the secondary fuel storage system.

The final utilization option includes the manufacturing and use of automobiles designed to burn straight methanol fuels. As mentioned earlier it is expected that these vehicles could be manufactured by the mid-1980's if demand warranted. If truly substantial savings are to be realized by substituting methanol for petroleum products, entire sections of Ontario's population will need to be employing these vehicles. Introduction of these vehicles could commence with the use of selected fleets throughout the province. Logical

candidates include those vehicles with centralized fuel distribution facilities -- taxis, government vehicles and transit systems both urban and inner-city. Alternately, fleets could be established under geographical boundaries. It would be relatively easy to choose a given area of the province and ensure the supply of methanol fuels on a widespread basis at a competitive price (using government taxation policies to maintain competitive pricing for methanol). A logical area of the province to establish such a fleet would be the Eastern region as defined by TEIGA.

Methanol Production Options

Methanol synthesis involving renewable feedstocks or hybrid developments involves three separate stages; gasification of the feedstock, modification of the resultant gas stream and liquidation of the gas.

Whereas the second two stages of methanol production are commercially proven technologies, gasification of biomass -- be it wood residue or municipal wastes -- is a relatively untried technology. Several thorough analyses of the available gasification techniques have been undertaken in the last several years, yet commercial systems have yet to be installed in Canada.[1] There exist currently a handful of wood gasifiers operating throughout the country, most of which could be considered as prototype gasifiers in the developmental stages.

a) Gasification

Gasification takes place when heat is applied to organic matter in an oxygen-deficient environment. The resulting gas contains varying amounts of hydrogen,

1. B.H. Levelton, An Evaluation of Wood Waste Conversion Systems, Environment Canada, 1978.

carbon monoxide, carbon dioxide, nitrogen and traces of other gases dependent upon the gasifier employed, the main variable having to do with whether oxygen is introduced to the combustion process rather than air.

Several wood gasifiers have been recently installed in Canada. The first large installation was conducted in Clinton, B.C. Early difficulties were encountered by the owners of the gasifier, Moore Canada, and the system was subsequently sold to Westwood Polygas who have been nursing the process along in an attempt to attain better working results. The main problems associated with the system had to do with the flow of the wood feedstock into the gasifier and the removal of the ash residue from the reactor chamber.

Two prototype installations have been recently installed on the Prairie provinces. A gasifier designed by B.C. Research was purchased by Saskatchewan Power and installed in Hudson's Bay, Sask. Similarly, Manitoba Hydro is currently producing gas from wood wastes which is employed in conjunction with existing generating facilities in Selkirk, Manitoba. Neither of the systems has been operational for a sufficient time framework to allow for a thorough analysis of the processes employed.

The gasification system which has received the greatest amount of interest is the PUROX gasifier developed by Union Carbide for the gasification of municipal solid wastes. The company has results from several research gasifiers as well as from a larger (200 ton per day) plant which has operated in South Charleston, West Virginia, using MSW as feedstock. With an overall thermal efficiency of between 75 - 80%, the system delivers a gas with an energy content of roughly

280 - 375 BTU/scf as compared to the approximately 150 BTU/scf gas produced from conventional gasifiers. Research regarding the use of wood wastes in the process is still required, although company officials do not anticipate any operational difficulties. According to Union Carbide employees familiar with the technology the sole limiting factor of the PUROX system continues to be the relative economies of gasifying the wastes.

b) Gas Stream Modification

The second stage of the methanol synthesis process involves the compression cleaning and shifting of the gas extracted from the gasifier. Commercial processes operating at thermal efficiencies of approximately 50% are currently operational. The potential remains for the addition of supplemental feedstocks to the gas stream to improve the energy content of the gas. Research has been undertaken on the possibility of supplementing the gas produced from wood wastes with either natural gas (methane) or hydrogen.

The potential introduction of natural gas deserves serious concern at a time when Canada's natural gas surplus is estimated at 2 TCF.[1] In their feasibility study of the potential for renewable resource derived liquid fuels, InterGroup Consulting Economists Ltd. analysed the possibility of employing a natural gas hybrid in the production of methanol. The use of methane as an input to the gas stream would increase the methanol output per unit of renewable feedstock by as much as 600% as that produced from simple gasification. For a plant with an output of approximately 100 million gallons per year (GPY), the requirement for natural gas would amount to 9.2 BCF and 152,000 tons of wood feedstock.

In their report prepared for the federal government's Fisheries and Environment

1. National Energy Board, Canadian Natural Gas Supply and Requirements, 1978.

Department, InterGroup[1] suggests the rationale for employing the methane hybrid process over the near term. The report suggests that the plants could be constructed without delay and could be operational within as little as five years. The plants would produce methanol at a lower price than would be the case from a plant employing wood wastes only. At least over the near term, the report suggests that methanol could be produced at a cost of between 36 - 40¢ per gallon (1978$) assuming oil prices at approximately $15.00/bbl.

As the cost of oil increases during the 1980's similarly the cost of natural gas will rise (assuming that gas moves towards parity on an energy basis with oil). As supplies become more expensive the input of methane could be phased out and replaced by renewable feedstocks. This process would also provide time to improve wood harvesting techniques, and would allow for the development of sound forest management strategies. Although the impact on employment and on the provincial balance of payments is less beneficial with the methane hybrid option, when viewed as a transitional technology it appears to hold great promise.

c) Liquification

The final stage of the methanol production process involves the conversion of the modified gas stream to a liquid state. Commercial processes for the synthesis of methanol from gas have been employed throughout the world, the majority of which have employed methane. No difficulties will be encountered in producing the methanol from gas derived from renewable resource feedstocks. In Canada methanol synthesis is conducted by Alberta Gas Chemcials and by Chemcell.

1. InterGroup Consulting Economists Ltd., Liquid Fuels from Renewable Resources, Feasibility Study, Fisheries and Environment Services, Ottawa, 1978.

SUPPLY OPTIONS FOR RENEWABLE RESOURCE DERIVED METHANOL IN NORTHERN ONTARIO

Introduction

Serious problems have been encountered in attempting to compile accurate data on the availability of biomass feedstock in Ontario. A complete and extensive forest resource inventory is required as soon as possible so that decisions affecting forest management, both in the near term and in the longer term, can be responsibly arrived at. The incompleteness of the existing information dealing with mill wastes, surplus forest residue, biomass availability in areas not currently being harvested and the potential for hybrid poplar energy plantations has been recognized for several years[1] yet very little work has been conducted to remedy this situation.[2]

In cataloguing the availability of forest biomass in northern Ontario we have not assumed using all the available biomass for methanol production. On the contrary, we are suggesting that wood wastes available at the mill sites be employed as fuels for the forest products industry. Similarly, we are suggesting that biomass in areas not currently being harvested remain untouched until improved forest management policies have been devised. We also consider the potential viability of biomass cultivated from hybrid poplar plantations, but make no effort to quantify the short term impact which this feedstock might have on the production of methanol in northern Ontario.

The only biomass we assume is available for methanol production is the slash from currently logged areas and the unutilized trees in currently logged areas. Further considerations may determine that the unutilized trees would more appropriately be left standing or cut for other purposes. But at the very least, the slash from these trees will eventually be available.

1. Observations as to the inadequacy of forest inventorying techniques have been made continuously since the mid-1970's.
2. Recent work by Dr. J.B. Thomas at the Sault Ste. Marie Research Laboratory has started to arrive at the thorough biomass yields/acre which are required.

In the event that the stems from these trees are used for other purposes, the numerous conservatisms in our analysis should more than compensate for the reduction. (For example, detailed biomass surveys now underway may indicate a much greater quantity of biomass per acre than we assume here.)

To provide sufficient biomass to sustain eight 1,000 tonne per day methanol synthesis plants, one need only harvest the surplus biomass remaining in the forests after conventional forest harvesting. The annual methanol production from these facilities will amount to approximately 736 million gallons. We do not necessarily advocate certain production levels nor do we attempt to pinpoint locations for the construction of methanol production facilities. These are fundamental questions which should be addressed by the people of the northern sections of the province. The decisions taken will influence the socio-economic make-up of this portion of the province while simultaneously they will have an impact on the northern environment. Decisions regarding these issues should be carried out by those who will be influenced by the results.

Supply Options

a) Hybrid Poplar

Substantial research has been conducted over the last several years investigating the potential of cultivating high yield biomass plantations for energy purposes. In Ontario the Ministry of Natural Resources has conducted extensive testing and demonstration scale production to determine the feasibility of growing hybrid poplar trees as a biomass feedstock. This work was originally conceived as a means of providing additional pulpwood to the pulp

and paper firms on the Ottawa River. Serious consideration has since been directed towards employing the biomass feedstock for energy purposes. Recent work has investigated the potential of employing poplar trees grown in Eastern Ontario as feedstock fuel for the generation of electricity. In his report to the Royal Commission on Electric Power Planning, Morris Wayman suggested that sufficient biomass could be cultivated in Eastern Ontario from 'poplar plantations' to generate 3200 megawatts of electricity.

While much of the research has focussed on growing hybrid poplar on abandoned farmland in Eastern Ontario, recent work has been carried out at some of MNR's northerly research facilities. Very positive results have been attained in the testing of growth rates of poplar in Eastern Ontario. Annual yields of 4 - 7.5 oven-dry tons (ODT) annually have been attained at various sites throughout the province, and MNR officials project that by the early 1980's sustainable yields of 10 ODT/acre will be realized. Harvesting has been conducted in mini-rotations (2 year growth cycles) and in longer (7 - 10 year cycles) rotations.

It is assumed that the harsher climatic conditions of Northern Ontario will restrict the yields attained and may indeed speak against any large scale development of the energy plantation concept. Whereas it has been estimated that as many as 10 methanol plants (92 mm GPY) could be sustained by biomass cultivated in Eastern Ontario, the potential viability of hybrid poplar plantations in the north will not be determined until further research is carried out. There has also been recent interest in the potential for "plantation-like" plantings of properly spaced and controlled nursery stock of spruce and jack pine.

b) Mill Wastes

Estimates as to the availability of hog fuels at mill sites in northern Ontario are somewhat sketchy. The "Report of the Raw Materials Task Group"[1] prepared in conjunction with the study of liquid fuel potential in Ontario estimated the amount of unused wood residue available at mill sites to be approximately 1.3 million oven dry tons annually.

The apparent surplus residue production at mill sites in northern sections of the province was estimated at 1.3 million ODT in 1974[2] but was expected to decrease substantially as the rising cost of conventional fuels forces the forest products industries into employing their own wastes for energy purposes. Regrettably, moves towards self-sufficiency by the forest products industries have been minimal with the exceptions of a few companies, most notably Great Lakes Pulp and Paper in Thunder Bay. Involvement of the industry has not been forthcoming even though prices of fuel are rising sharply and substantial funding has been made available through the federal government.

The residue fuels available at the mill sites are comprised primarily of bark, sawdust and shavings and are usually easily accessible. In many cases, the producer of the wastes incurs a penalty as they must be disposed of. The conventional disposal techniques involve combustion in teepee ovens or trucking the wastes away for disposal as landfill, equally expensive and envrionmentally disruptive.

Whereas we could have suggested that these excess residues by employed as feedstock for the production of methanol in northern Ontario, we believe that thsee residual wastes have a preferred value as fuel for the forest products

1. Raw Materials Task Force, Candidate Raw Materials for the Production of Synthetic Liquid Fuels in Ont., Ministry of Energy, 1977.
2. R.J. Hall, Resource Availability and Utilization of Forests for Energy, Ontario Ministry of Natural Resources, 1976.

industries. More specifically, the hog fuels could be employed as feedstock for the cogeneration of electricity or for the production of process steam. Thermodynamically a development strategy based on promoting increased self-sufficiency within the forest products industry is far more efficient, as the conversion losses can be minimized. We hope that any recommendations which the commission makes regarding the use of mill residue will reflect this optimization of thermodynamic efficiency.

Studies such as the waste wood availability inventory prepared in the Hearst region of the province are required for all of the major forest industry centres. Sound analysis of the biomass availability is a prerequisite to the evolution of forest management policies which best reflect the environmental and economic concerns of Northern Ontario. Reliable analyses are required for all areas of the province, dealing with forest residue at the mill sites, that which is left over from conventional harvesting practices, and that which is in areas currently considered to be economically inaccessible.

c) Forest Residue

As previously mentioned, the entire area of biomass inventorying techniques is a very new and previously neglected issue. Biomass calculations are especially sketchy in the area of forest residue, or that part of the tree which is left in the forest after conventional forest harvesting had taken place. This 'bush residue' accounts for a substantial amount of the surplus biomass which might be made available as feedstock for the production of methanol in northern Ontario.

In Ontario, only 50% of the allowable hardwood cut and 85% of the allowable softwood cut is actually removed during logging, due to the prevailing utilization standards of the industry. In addition to this waste there is the""non-marketable" slash and unutilized trees (diseased, small, undesirable species, etc.). Estimates of the total amount of wood left behind after conventional harvesting range from 30% of the harvested volume to 230%.

Estimates as to the accumulations of these residues in Ontario forests range from 5.4 x 10^6 ODT[1] to 8.5 x 10^6 ODT annually[2]. For northern Ontario the figure which we will employ is closer to 7.0 x 10^6 ODT annually[3]. This figure is derived from several sources but is best considered to be a "ball-park" estimate due to lack of complete information. The accumulation of these wastes can be divided into a regional breakdown as was carried out by R.J. Hall of MNR.

Bark and Wood Fibre Production from Primary Milling and Forest Harvesting Operations

Region	Bush Residue	Bush Unutilized Wood Fibre
NorthWestern	701	387
North Central	1,567	550
Northern	1,176	850
NorthEastern	923	849
Subtotal	4,367	2,636
Total		7003 x 10^3 short tons = 6353 x 10^3 odtonnes

Assuming that a 1000 tonne per day methanol facility requires 759 thousand oven dry tonnes annually, on a theoretical basis the 6.35 million oven dry tonnes

1. R.J. Hall, op cit.
2. Advisory Group on Synthetic Liquid Fuels, op. cit.
3. 7.0 ODT assumes the yield from the Northern, North Central, North Western and North Eastern forest regions.

could sustain eight plants with an annual production of 736 million gallons of methanol. If this fuel were used to displace gasoline consumed in the transport sector in Ontario, the methanol would account for almost 14% of total energy consumed in the transport sector.[1]

Inadequate inventorying techniques have restricted any attempt on our part to pinpoint candidate locations for methanol production facilities employing surplus forest residue. As these forest residues are the result of ongoing conventional forest harvesting, we can assume that production facilities will exist in those areas of the north which currently are involved in the forest products industry. One of the most beneficial aspects of a development strategy which includes methanol production is the relative flexibility which one is afforded in choosing plant locations.

d) Wood Available in Areas not Currently Utilized

Additional surplus biomass is available in areas throughout the province which at this time are considered to be economically, environmentally or technically restrictive. In their 1976 report, InterGroup suggested that as much as 52 million ODT was available in stands of timber not currently being harvested. The Raw Materials Task Force of the Advisory Group on Synthetic Liquid Fuels estimates in excess of 10 million oven dry tonnes which is available from Ontario's neglected areas. Although the biomass potential for these areas is truly significant, especially when viewed over the long term, in our analysis of the potential for methanol development in Northern Ontario we have consciously not considered this biomass potential. It is a commonly held belief both within

1. This estimate is based on 1975 transport demand of 82.5 million barrels consumption. Methanol is valued on an energy basis at slightly more than 50% of an equivalent volume of gasoline. This does not take into account the fact that efficiency improvements are realized from the use of methanol of as much as 25%.

and outside the forestry industry that forest management practices as currently exercised in Ontario are woefully lacking. It is our belief that we should demonstrate a much improved ability to deal with those sections of the forests which we have already brought to the edge of destruction before larger, more environmentally sensitive tracts of land are made available for logging purposes.

IMPLEMENTATION STRATEGIES

Several actions must be taken in the near term to ensure an orderly introduction of methanol production and utilization in northern Ontario. At the present time there exists an obvious lack of central coordination in designing a strategy for the appropriate development of renewable resource derived liquid fuels. Currently in Canada the potential for a methanol industry is being promoted by a very small group of individuals, many of whom are business people or bureaucrats attempting to promote a vested interest. Federally the most vocal support for a methanol industry has not emanated from Energy, Mines and Resources, nor from the Department of Regional Economic Expansion, but from The Canadian Forestry Services, a division of Fisheries and the Environment.

If indeed the development of a methanol industry falls within the framework of a development strategy for which the people of northern Ontairo have voiced their approval -- be it for reasons relating to employment, regional economic expanison, decreasing supplies and increasing costs of conventional liquid fuels, or positive environmental implications -- it will become important to pull together all of the 'actors' who will influence (or be influenced by) the development of methanol production and utilization in the north. To ensure a balanced approach to the development of sound policies, representation will be required from the manufacturing sector, for the forest products industry, from the many levels of government regulating and influencing northern development and forestry practices, as well as from the people of the north. Unless each of the above is given a voice early in the developmental stages, more serious problems will occur in the future due to basic communication breakdown. The involvement of all levels of society in the decision-making process is a pre-

requisite to any changes in our energy supply systems, if they are to be successfully introduced.

It is suggested that a coordinating body be established to oversee the initial developmental stages. This body -- the mandate of which would be the promotion of an orderly development of methanol fuel production and utilization -- would be made up of people familiar in the areas of biomass resource availability and harvesting technologies, forest management, methanol production technologies, distribution and marketability of liquid fuels, resource taxation policies, and social and environmental impact assessment.

Not only should this group be charged with the responsibility of establishing goals for the production and use of methanol in northern Ontario, but it should also design a framework for the creation of a new industry. Some of the options which have been considered include the formation of consortia of firms with the required expertise for methanol production, the formation of a Crown corporation devoted solely to the methanol supply industry, or the provision of substantial government subsidization of smaller firms employing newly developed processes.

The concept of promoting the formation of consortia would involve attempting to sell the idea of a joint venture between existing forest harvesting companies, firms with expertise in gasification and petrochemcial refining capabilities, and industries with a proven ability to distribute and market liquid fuels in large quantities. In analysing the requirements for such a consortium one quickly realizes that development of methanol production and distribution

facilities will be a significant task, and that it lends itself to larger corporations. Regrettably, the economics of methanol production at this stage demand a slight variation from the 'soft path' approach to energy supply systems, and although in relative terms its development is decentralized, it will require somewhat conventional development strategies. Improved gasification design and systems improvements in the future may warrant a smaller, more appropriate development strategy, but at present methanol development strategies appear as relatively large and centralized by nature.

The subsidization of smaller firms wishing to enter the developing methanol production field would be necessary in order to overcome the high front end costs involved in the establishment of resource harvesting and production facilities. If there is to be a role at this stage for the smaller interests it will probably be in the area of feedstock procurement. Many of the technologies referred to in the section on forest management could be employed by smaller firms or even by cooperatively operated ventures. Smaller forestry firms and trucking firms may be able to find a place for themselves in this developing area.

The compelling reason for supporting the creation of a Crown corporation charged with the development of a methanol industry in northern Ontario involves a concern that development pursued by existing industry will be hampered because of conflicts of interest which would arise. Expecting that existing petroleum firms will rush to provide methanol at the pumps would be foolhardy.[1] To think that pulp and paper companies would not be confronted with a potential conflict between feedstock for pulp versus feedstock for methanol is equally naive.

1. Results with the marketing of gasohol (10% ethanol and 90% low lead gasoline) have proven extremely successful in the mid-western U.S. Most gasoline

One of the means of ensuring that the needs of the people of northern Ontario are met when considering the development of a new energy supply industry would be to allocate at least 50% of the seats on the board of directors of such a Crown corporation to citizens of northern Ontario. This would not be dissimilar to legislation affecting the make-up of the boards of foreign owned companies with subsidiaries in Canada, and would greatly aid in the development of policies which were of lasting benefit to the north.

Were a Crown corporation to puruse the initial development of a methanol industry in northern Ontario, fewer conflicts of interest would arise, fewer jurisdictional difficulties would be encountered and a speedier implementation of this new energy production would occur. The Crown corporation should enter the market with the avowed intent of turning the industry over to the private sector once the viability of the technologies employed and the profitability of the industry was established.

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companies have been receptive to the idea. The most significant difference between their experience and the authors' opinion involves the relative long term potential of methanol (potentially 20 billion gallons annual production) as compared with the ethanol fuel which is produced from surplus agricultural products.

DISTRIBUTION OF METHANOL PRODUCED IN NORTHERN ONTARIO

Several options exist when considering the utilization of any methanol produced in northern Ontario. Initial use of the fuels in the north should be maximized, with methanol eventually providing 100% of the liquid transport fuel requirements. A surplus of methanol will exist in the north and decisions affecting the transportation of the fuel to southern or western markets will need to be analysed so as to maximize the benefits accruing to the north regions of the province.

An analysis of the transport demands in northern Ontario will suggest the potential displacement of gasoline and diesel fuel which might occur if substantial volumes of methanol were made available. Current consumption of gasoline for automobiles north of the French River system is approximately 29.4×10^{12} BTU.[1.] The necessary volume of methanol to displace this fuel would amount to 380 million gallons, the equivalent output of slightly more than 4 production facilities (@ 1,000 tonne/day).

Transportation energy demand in the forest products and paper sector account for .38% of provincial gasoline consumption and 4.06% of the diesel oil demand[2.]. Juggling these figures with demand in 1975 and accounting for only the demands of northern Ontario industry (80% of forest products industry) the demand for liquid transport fuels can be estimated at 5.19×10^{12} BTU ($.70 \times 10^{6}$ gallons net) or slightly less than the output of one methanol plant.

In total the transport demands for private automobiles in conjunction

1. Assumes a population of 818,000 (provided by Northern Affairs, Ont.), at 2.5 people per automobile, average annual mileage of 12,000 = 196×10^{6} gal. gasoline.
2. Utilization of Methanol Based Fuels in Transportation, D. Elliot (1978).

with the consumption of the forest products industries amounts to 34.59 x 10^{12} BTU. Five methanol plants (@ 1,000 tonne/day) would be required to support this demand[1]. supplying approximately 460 million gallons.

As earlier mentioned, maximizing the use of methanol in northern Ontario will decrease transmission losses associated with exporting fuels to southern markets. There does exist, however, a considerable surplus of methanol in northern Ontario, even when assuming a conservative biomass availability.

Two options exist for transporting fuels to southern markets. In the short term surplus methanol could be shipped in tankers or the lakes, or piped via pipeline to central refinery capacity where the fuel could be introduced in a blend with gasoline. If the remaining methanol available in the north (after 'domestic' use) were blended with gasoline in southern Ontario, savings of gasoline in the order of 7% would accrue.

1. Efficiency improvements forecast to the year 1990 will allow for even further displacement of conventional liquid fuels.

ENVIRONMENTAL IMPACT OF METHANOL PRODUCTION

Large scale production of methanol from renewable resources can be managed in a manner which is responsive to the specific environmental frailties of Ontario's northern regions. Certainly the viability of this energy production option would need to be severely questioned if such were not possible.

We have dealt elsewhere in this paper with the potential beneficial impact of new harvesting practices which would result from increased biomass yields. Substantial improvements would also be realized at the production facilities themselves when compared with conventional energy supply technologies.

Methanol production facilities can be situated in close proximity to the full feedstock thus limiting many of the environmental problems associated with the transportation of crude feedstocks to refinery sites. Similarly the production facilities will be located closer to the site of end use than would be the case of technologies such as frontier oil, oil sands developments, and liquid natural gas.

In relation to the combustion of fossil fuels (oil, gas and coal), the gasification of biomass feedstocks will produce very low sulphur emissions and no significant increase in the long-term atmospheric CO_2.[1]

In comparing methanol production with the generation of electricity from Alberta coal (proposed for Atikokan), the benefits of producing a given amount of energy (21.0×10^{12} BTU/yr.) from methanol rather than from coal-generated electricity becomes obvious. With a similar capital investment of approximately $550 million a similar amount of energy is produced annually -- 17.9×10^{12} BTU in the proposed (1978) 800 MW coal fired station, as opposed to 21×10^{12}

1. Dr. T.B. Reed, Proceedings, React '78: A symposium on Economics of Renewable Energy and Energy Consevvation Options, published by Biomass Energy Institute, Winnipeg, Manitoba, 1978.

from three 1,000 tonne per day methanol facilities. The similarities end at this point. For that similar capital cost per unit annual energy, the methanol plant produces almost seven times as many man-years of employment. The coal station, would, however, produce more SO_2 (57,330 tons/year), more thermal pollution (approx. 35×10^{12} BTU) and would lead to a greater build-up of CO_2 in the upper atmosphere.

Base Case Methanol Production Facilities[1.]

Simple Gasification Plant:

Output:	1000 tonnes per day (91 million gallons annually)
Feedstock requirement:	2300 oven dry tonnes/day (759 x 10^3 ODT/year)
Capital cost:	$181 million (1978 dollars)
Employment generated:	100 - 200 full time jobs at the plant sites
	-1200 - 1500 man-years involved in the construction
	-approximately 700 full time jobs associated with harvesting feedstock for the production facility; this would add an additional $67 million capital cost associated with harvesting equipment.[2.]
Energy produced:	7 x 10^{12} BTU annually
Projected methanol cost:	47 - 64¢/gallon (1977 dollars)*

Methane Hybrid:

Output:	1000 tonnes per day (91 million gallons emthanol/year)
Feedstock requirement:	380 ODT/ day and 25 million cubic feet of natural gas/day (125 x 10^3 ODT/year + 8.5 bcf/year)
Capital cost:	$91 million (1978 dollars)
Employment generated:	45 - 90 fill time jobs at the plant site
Energy produced:	7 x 10^{12} BTU annually
Projected Methanol Cost:	38 - 40¢/gallon (assuming 1977 dollars and oil at $15/bbl)*

* Methanol contains roughly 52% of an equivalent volume of gasoline. One gallon of gasoline = 1.9 gallons methanol.

1. The base case plant assumes 330 day operation per year.
2. The corresponding number in the report prepared by Resourcecon is 1030 to 1375 man-years annually.

Chart adapted from Liquid Fuels from Renewable Resources: Feasibility Study (1978).

Biomass Energy and Forest Management

The development of a demand for energy from biomass will place new on the forestry sector for material which is not currently considered marketable. Although this material is unlikely to be suitable for high quality uses such as pulp and chipboard, there may be some competing applications such as insulation, fertilizer additives, mulches, soil mixes, cattlefeed (?), oils (?), etc. It is anticipated, however, that the primary demand for this biomass (foliage, bark, branches, etc.) will be for energy -- either by direct combustion, methanol production or some other conversion technology.

The development of a market for the "slash" biomass will encourage full tree harvesting, and this will have considerable impacts on forestry management practices. It is the purpose of this section to consider what these impacts might be and to anticipate how full tree harvesting might enhance the move toward intensive forest management and expanded yield forestry.

There are striking parallels between the development of energy use and the development of forestry in this province. Both sectors have enjoyed a long history of high growth at the expense of the depletion of a very large, extremely cheap and easily exploitable resource base. In the case of the energy sector, this resource base has been comprised of Mid-East oil, North American natural gas and large domestic hydroelectric potential. In the forest sector, the the resource base has been the natural forest -- at one time nearly 60% of the land area of the province was covered with productive forest land. Both the energy sector and the forestry sector have now used up most of their respective resource bases. Global oil production is expected to peak before

the end of this century; the inexpensive, large hydroelectric potential has been utilized in Ontario and frontier sources of natural gas, although relatively abundant, are costly compared to traditional sources. As for the forest sector, timber shortages are forecast by the mid-eighties.

The energy and forestry sectors are both facing greatly increased financial costs, ecological risks and technical difficulties in procuring marginal increases in supply. Tar sands oil and Arctic gas require up to ten times or more the capital required to increase supply only ten years ago, and also require the development of complex technologies and intrusion into delicate ecosystems in remote regions. Analogously, there is some doubt as to whether the northern boreal forest could ever recover from a logging operation such as the Reed proposal; and Reed itself has admitted the costs of the project make it marginal at best.

In both the energy and forest sectors, waste is rampant. Our society wastes between 50% (First Law efficiency) and 85% (Second Law efficiency) of the primary energy consumed. In the forest sector, the scaled harvest represents about 60% of the biomass of the cut trees and is estimated to be only about 36% of the biomass on the logged area.

Perhaps most important, both the energy sector and the forest sector are facing the difficult but inevitable transition to dependence on a sustainable, renewable resource base.

The issues and choices in the energy and forestry sectors are not identical, but there are interesting parallels between the policy goals of increased development of conventional energy supplies versus extensive forest management; conservation and increased energy efficiency versus closer utilization;

and development of renewable energy versus a greater commitment to regeneration and eventual expanded yield forestry.

Proposals to utilize the energy from forest biomass (including the potential for methanol production), bring together the spheres of energy planning and forest management.

The development of a market for the unutilized biomass material in the forests cannot be viewed simply as one more demand on the total forest inventory. Rather, it is necessary to integrate such development with currently evolving forest management priorities.

For decades, the forests in Ontario have been cut over at a faster rate than they have been regenerated. This has been a particularly severe problem in the north, as shown in the table below.

Regeneration on Crown & Patent Land by Region, 1973/4 - 1975/6
(' 000 hectare)

	Northwestern Ontario *	Northeastern Ontario *	Southern Ontario
Total Cutover	205	253	124
Natural Regen.	62	94	99
Area requiring Treatment	143	159	25
Area Regenerated Artificially	79	71	54
AREA LOST TO PRODUCTION:	64	88	(29)

* In this table, Northwestern Ontario and Northeastern Ontario correspond, approximately, to the OMNR Norhtwestern, North Central and Northern Regions.

In the north, some 150,000 ha. per year are being added to the existing backlog of unregenerated and burned forest land that has been lost to production. It represents a dwindling away of one of our most precious and vital resources.

There are a number of reasons which are contributing to the gradual depletion of our forest resource -- some are technical and some are political and institutional. The Commission is undoubtedly aware of the recent literature on this topic. Suffice it to note here that the single most important problem has been and continues to be the attitude that the forest represent resource capital to be exploited and not a renewable source of value to be managed. As Professor Armson has written, "the fact that the forest is viewed as a resource to be exploited is still the most serious impediment to forest management".

There is a broad consensusthat, in order to divert our forest industry from its current disastrous course, we must

a); improve regeneration of cutover sites so expanded yields are achieved instead of a dwindling surplus and eventual declining yields: and

b): practice intensive forest management to increase the harvest per acre.

Implementaion of both these broad measures could be assisted, directly or indirectly, by the development of a biomass industry utilizing the slash and residual trees from currently logged areas.

The problem in site treatment in the boreal forest is mostly due to the large amount of slash and residual hardwoods left standing on logged areas. These were identified as the number one and two problems of site preparation at a recent conference on regeneration in the northern forests:

> Unwanted species are left on the site in such quantities that any kind of silvaculture treatment is uneconomical or doomed to failure if it is tried. Our reference here is to trees left standing. It is a fact that the lighter the partial cut, the greater is the

proportion of the tree that is left as slash on the ground. This also hinders silvacultural work."1.

As the market develops for the energy in the biomass of the slash and residual hardwoodsand unwanted species, it will be possible to harvest all of the trees (except perhaps some seed stock), and nearly all of the biomass. This will leave an improved seedbed and better environment for natural or artificial regeneration. The government could encourage this development by insisting that the forest be logged cleaner or by providing incentives for closer utilization. (eg. lump sum sales, encouraging small operators , etc.)

There are a number of other problems that contribute to the poor regeneration of the boreal forest, including site damage by logging and road building machinery, poor seed quality, inadequate trained staff, poorly suited nursery stock, extensive clearcutting, lack of all weather road systems, etc. Most of these problems are to some extent the result of an insufficient level of intensive management of the forest. With the development of the biomass energy market, the value per hectare of the forest will increase and there will be incentives for more intensive management, including more professional foresters per hectare and more and more research on silvacultural problems.

In conclusion, a preliminary analysis of the forest management implications of a forest biomass - based methanol industry appear to be positive.

1. Ontario Ministry of Natural Resources, "Closing the Gap in the Northeastern Region", Proceedings of the Conference on Regeneration, Thunder Bay, March 29 - 31, 1978, p. 4.

THE ECONOMICS OF METHANOL PRODUCTION

The economic analysis of methanol production from renewable resources has appeared as a highly controversial issue over the last year. Specifically, two large reports investigating the technical and economic viability of methanol production have been published in Canada within the last twelve months. The first study to be released was prepared for the Federal Department of Fisheries and the Environment in conjunction with Energy, Mines and Resources by a Winnipeg Economic consulting firm, InterGroup Consulting Economists Ltd.[1] Only months after the release of the federal study, the province of Ontario released a report entitled Liquid Fuels in Ontario's Future: Findings and Recommendations.[2] The report was prepared by the Advisory Group on Synthetic Liquid Fuels of the Ministry of Energy and drew heavily upon an economic analysis conducted by Canadian Resourcecon Limited of Vancouver. Serious conflicts exist between the conclusions of the respective authors.

The report prepared for the Federal Government analyses the production of liquid fuels from renewable resources, with specific emphasis on the production of methanol from forest residue.[3] Several options are analysed in determining the production routes to be followed, but the majority of attention is focussed upon the gasification of wood residue employing a PUROX gasification system. The report suggests several hybrid developments whereby the gas extracted from the reactor could be supplemented with either natural gas or hydrogen in order that the energy content of the produced gas was improved. A thorough analysis of the production technologies involved in the synthesis of methanol from renewable resources, the harvesting techniques required to provide biomass to the plant, and the availability of forest residue throughout the country is conducted by the authors of the report.

Similarly the InterGroup report analyses the potential market for methanol fuels, the technical alterations which would be required for the marketing and use of methanol, and the projected costs at which the fuel could be produced under several scenarios. The report goes on to analyse thebbenefits which would be gained by prrsuing the development of a renewable resource-based liquid fuel, socially, environmentally and economically. The report suggests that over the near term substainial benefits will be derived from the development of a methanol industry. It suggests that an investment of $2.5 to 3.0 billion ($1977) would lead to:

- the construction of 10 to 30 separate plants across Canada
- the creation of 14 to 20 thousand man-years of construction work
- a reduction in our requirements for crude oil of 40 mm bbl/year.

Over the longer term the report suggests that Canada's renewable resource base could sustain methanol production on the order of 20 billion gallons annually.

The InterGroup study suggests that methanol produced from forest residue with additional input of natural gas could be produced in the near term and would be considered economically atrractive if oil import prices attained $15 to %20 per barrel. At present imported oil has reached the level where InterGroup forecast methanol produced with a methane hybrid would appear economical. Methanol derived solely from forest residue was projected to become economical when imported oil reached $25/bbl (1977$) in many areas of the country, with the more inaccessible, lesser forested areas of the country becoming viable production centres for methanol when the import price reached $35/bbl.

Substantial differences exist between the conclusions arrived at by the InterGroup report and the report prepared for the Advisory Group to the Ontario Ministry of Energy, the economics of which were prepared by Canadian Resourcecon

Ltd. of Vancouver. The report states that there is no economic justification for a demonstration plant of synthetic liquid fuel production in Ontario.

The work by the Advisory Group is devoid of any of the enthusiasm exhibited in the InterGroup study for a fuel derived from renewable resources. The environmental benefits to be accrued from such a development strategy, and the desire to develop indigenous Ontario resources are downplayed within the report, in the study group's eagerness to import cheaper western coal and tar sands oil.

While the reports differ in many cases on costs, feedstock availability, and technical parameters, these issues could be resolved if access to the background information were obtained. The more significant problem one encounters in comparing the studies is attempting to analyse the values which are manifested in the final products.

Whereas many have accused the InterGroup study of being overly optimistic in its appraisal of the potential for renewable liquid fuels, others have attacked the report prepared for the Ontario Ministry of Energy for being far too pessimistic. The number of variables and permutations makes a thorough analysis of the studies nearly impossible. At this point, most of the individuals who have been involved in the debate have concluded that the sole means by which the issue can be resolved involves the construction and operation of a large demonstration methanol facility.

And yet over the last six months little, if any, attention has been directed towards the methanol issues. Unduly limited focus on the technical and economic issues tends to obscure the rationale for decision making in the energy supply field. Methanol must be viewed as more than just a fuel which may substitute for gasoline in the fuel tanks of our automobiles. Any adequate assessment of the methanol option entails considerations of its broader implications. If one considers

the employment that would be created in the north by a serious effort to develop methanol fuels from renewable resources, the economic stimulus that would be given to the northern areas of the province and the benefits of a development strategy that could provide long term, socio-economic viability, then the squabbles over whether the price of oil needs to reach $25/bbl or $30/bbl before the methanol becomes cost effective' become quite insignificant, for in the end it is people, communities and environments that matter the most.

Employment Impact of Methanol Production

Methanol production is one of the most labour intensive energy supply options available in Canada. The chart below draws upon 1976 figures and demonstrates the relative weightings of the employment created by a $1 billion capital investment in several energy systems.[1]

Methanol production yields 60,000 man-years of employment for a capital investment of $1 billion (1976$). A similar investment in nuclear generated electricity will provide only 14 per cent of the employment of a methanol development. In times of high unemployment, the effect of investments in the energy supply sector must be evaluated with special reference to their job creation potential. It is within this framework that the benefits of methanol production are exhibited.

Each 1000 tonne per day methanol systhesis facility would require a labour force on site of approximately 100 to 200 people.[2] More significantly, the impact of a methanol industry on employment in the forest harvesting sector would multiply the labour input per plant by as much as a factor of 5. Estimates of the labour force needed to harvest the biomass feedstack range from 300 to 1375, depending on the location of the biomass and the

1. C. Conway, "Energy and Employment", Probe Post, May 1978, p.3.

2. Assuming simple gasification; methane hybrid plants would need 45 to 50 people.

harvesting technologies employed. The total labour input required to run a 1000 tonne per day methanol production facility is estimated at between 900[1] and 1500[2] man-years annually. Construction of eight methanol plants would provide in the order of 12,000 man-years of employment.

A development policy consistent with that suggested in this report (i.e. eight plants), would have a significant effect on the economy of northern Ontario. The direct employment effects of such a strategy would amount to approximately 8800 to 13,600 man-years annually (involved in the operation of, and materials handling for the plants) new employment in northern Ontario.

Although the numbers of jobs that would be created by a methanol development program are indeed substantial, the real benefits to be derived from such an industry relate to the flexibility allowed in placing production facilities. Methanol production facilities could be constructed in those areas of the north with above average unemployment figures or in those areas requiring economic stimulus. Whereas conventional energy supply projects have moved continually farther from population centres to frontier areas of the country (the Arctic Islands, Mackenzie Valley, Labrador offshore), with methanol the opportunity exists to produce substantial quantities of energy in northern Ontario, employing local labour forces.

1. InterGroup Consulting Economists, <u>Liquid Fuels from Renewable Resources</u>, 1978.
2. Canadian Resourcecon Limited, <u>Economic Analysis of Synthetic Liquid Fuels</u>, 1978, p. V-20.

NORTHERN DEVELOPMENT

Economic development in the north should serve the interests of the people of the north; their needs should not be considered second or third to the demand for raw materials and resources in southern Ontario and other distant localities.

There has been and tinues to be a clear lack of control over northern development by people in the region. Municipalities have been slow to develop strength and other existing political institutions have failed to rally unified support in the north. The desire for regional separation has been apparent as far back as 1880 in the representations of both the white and native northern populations. The assignment of provincial status to Manitoba and Saskatchewan at the turn of the century once again gave impetus to the call for an autonomous north.

Unfortunately, the powers in control of northern development, chiefly large multi-national corporations, are aided by Ontario's exploitative attitude to its hinterland. There is not yet a political, economic or social entity articulating northern Ontario's interests in any position of influence.

Local public participation in the decision-making process is essential to good northern development. It is our concern that the basic democratic right of citizen participation in decision-making is in danger of being jeopardized as economic issues become more technical and complex. The true issues in northern development are really of a more human order and the solutions to most of the problems of northern development require not technical expertise, so much as the application of natural justice and plain common sense by an informed public.

One problem we see is that many northerners tend to ally their personal interests with large-scale externally-controlled resource industries assuming

that foreign capital and large enterprises are essential to resource development. Privately owned lumber and mining companies have often been purchased by northerners for the express purpose of speculation -- selling their assets to a multi-national corporation, thus stifling locally-initiated industrial growth and employment.

The native population, on the other hand, is clearly aware of the difference in priorities between themselves, government and corporate groups. They are aware that the short-term corporate goals of a multinational company may directly conflict with the significance of wildlife resources which, to Indians, exceed the monetary value of the harvest. The concept that the land and the people are one is very real to northern natives and little understood by Euro-Canadians.

Implementing a methanol industry in the north would require that we adopt a sound program of forest management. Rather than mining forests we should heed the native plea that whatever is environmentally incorrect will never be economically sound.

The mayor of Blind River, Red Venturi, speaking in reference to what might be termed almost three-quarters of a century of mining the area's forests of white pine, said,

> "Since the very beginning, I think all the lumber companies, not just Domtar, cut what they knew as the real money maker, the white pine. Unfortunately over the years billions of pulp slashed in the process was left and allo ed to rot on the ground.
>
> "Sooner or later this could only mean the depletion of the forests and I am certain that Domtar foresaw this, in fact knew years before, that mill closure was inevitable." 1.

The social disruption of a large-scale resource project economy has taken its toll on the people of the north.

1. Sault Daily Star, De.c 6, 1978.

The phenomenon of families being split as out-of-work husbands go off to other parts of the country seeking employment when the mine or lumber mill in their community closes down has become a fact of life in northern towns -- Sudbury and Atikokan are recent examples.

Layoffs occur principally among the young who suffer from an unemployment rate 4% higher than their counterparts in southern Ontario.

Many young northerners are forced to leave, especially the well-educated, contributing to long-term family separations due to lack of steady employment opportunities.

Whereas from a northern Ontario perspective this is damaging to the fabric of family life to the Ontario Economic Council this exodus of youth from northern Ontario is regarded as beneficial -- bringing population more in line with job opportunities in the north.[1.]

Extreme cases of social disruption in the north has often involved native populations. Such is the case of the White Dog Rese ve dislocated for the purpose of an Ontario Hydro dam project which was not even intended to include servicing their community with electricity.

The insensitivity of provincial and federal governments and crown corporations to local needs necessitates that more regional authority and expertise must be developed to protect northern communities from suffering massive environmental impacts of large developments which are often proposed by the government itself.

1. Jamie Benefickson,"Northern Ontario: Problems and Prospects, Past and Present" Alternatives, Autumn 1978.

COMPARATIVE ANALYSIS OF ENERGY PRODUCTION FROM METHANOL PLANTS AND COAL FIRED THERMAL-ELECTRIC GENERATION OF ELECTRICITY

Almost all changes bring some problems. Proposed changes that would replace established technologies and alter existing infrastructures are often met with skepticism if not outright opposition. But at this stage in our history, major changes, particularly in the energy field, are unavoidable. Recognizing the approaching limits of affordable conventional energy sources, we can either choose now the most reasonable means of making the necessary transitions, or delay until the options have narrowed and little choice remains.

We now have several technically viable options for future energy production Their relative merits are determined by comparison of their economic, social and environmental implications. Chart A compares the possibility of producing energy from three 100 tonne per day methanol plants with an alternative energy investment in the coal-fired thermal-electric generating station proposed by Ontario Hydro for construction at Atikokan.

From an energy production and capital cost point of view the two are roughly equivalent. The Atikokan plant would be slightly more expensive to construct ($562 million compared with $543 million for the three methanol plants), more costly to fuel ($112.5 million annually for coal compared with $91.1 million annually for oven-dry wood), and would produce somewhat less energy (17.93 trillion BTU of electricity compared with 21.0 trillion BTU of methanol). The energy output per capital investmen would be about 21 per cent higher for the methanol option - a significant, but not extraordinary advantage.

The major differences lie in the relative employment, environmental and local economic implications. Operation of the three methanol plants would provide full time employment for 300 to 600 persons directly and for another 2100 persons in related woodlands operations, for a total provision of 2400 to 2700 full time jobs. The Atikokan plan, in contrast, would provide only 200 full time jobs directly and 566 more in the mining, preparation and transportation of coal, for a total of 766 full time jobs.

Though the Atikokan emissions of sulphur dioxide would be low relative to those of sources such as the Nanicoke coal-thermal station in southern Ontario, which emits several hundred thousand tonne of sulphur dioxide annually, (or the International Nickel smelter in Sudbury, which is allowed to discharge well over a million tonne per year), the Atikokan emissions would add to already threatening loadings in north-central United States and northern Ontario. Because of sulphur dioxide (and to a lesser extent nitrogen oxide) air pollution, precipitation even in northwestern Ontario, far from the major North American sources of industrial air pollutants, is several times more acidic than normal. This is of particular concern because most of the area has insoluble precambrian bedrock, thin overburden and, as a result, little capacity to buffer (neutralize) the precipitation-borne acids. Acidification of waterbodies in northwestern Ontario would kill sport fish and cause considerable economic damage to the tourism and recreation industries.

Finally, since the methanol plants would be fuelled by local resources, the economic benefits of fuel payments would remain in the region, in contrast to the case of the Atikokan plant, which would pay out $112.5 million to Alberta annually for coal.

It would seem, therefore, that the methanol option for energy production is economically competitive and would provide more significant socio-economic

benefits to the people of the area in a manner more compatible with environmental concerns than would the proposed Atikokan coal-thermal gneerating station.

COMPARISON OF THREE 1,000 TONNE PER DAY METHANOL PLANTS[1] WITH THE PROPOSED (1977) ATIKOKAN COAL-FIRED THERMAL-ELECTRIC GENERATING STATION[2]

	Plant size	Annual output	Fuel requirements	Capital cost
Atikokan	800 MW	$5,126 \times 10^6$ kwh (17.93×10^{12}BTU)	2.25×10^6 tonne coal/year @ \$50/tonne = $\$112.5 \times 10^6$	$\$562 \times 10^6$
Methanol	3 @ 1,000 tonne/day methanol	273×10^6 gallons (21.0×10^{12} BTU)	$2,277 \times 10^3$ ODTonne /year @ \$40/ODTonne = $\$91.1 \times 10^6$	$\$543 \times 10^6$

	Annual energy per \$ billion of capital	Jobs created	Pollution emissions	Provincial balance of payments
Atikokan	31.92×10^{12}BTU	200 full time 4265 man-years in construction 566 man-years in operation of fuel cycle (3)	55.725 tonne/year sulphur dioxide	$\$112.5 \times 10^6$ (Alberta coal)
Methanol	38.64×10^{12}BTU	300-600 full time 3600-4500 man-years in construction 2100 full time jobs in harvesting	minimal	negligible provincial effect positive regional effect

notes:
(1) All methanol data are taken from the base case (see chart) and multiplied by three plants.
(2) Except where indicated, Atikokan data are taken from Ontario Hydro, Proposal for Atikokan Generating Station, May 1977. A 75 per cent capacity factor is assumed for the generating station.
(3) Adapted from "Manpower Requirements for Nuclear and Coal Power Plants", a draft report of the Energy Efficiency Conference, Washington, May 20-21, 1976, Chart 17.

CONCLUSIONS AND RECOMMENDATIONS

The Royal Commission on the Northern Environment has been charged with the responsibility of investigating the impact of past and future development in Northern Ontario. When dealing with energy developments in a historical context, the greatest concern was over the amount of energy that was to be made available, the number of jobs associated with the construction of the facilities, and most recently, the environmental impacts of large energy supply projects.

It has been our intention in this brief to suggest that many other factors must also be evaluated when considering energy developments. We have demonstrated how the development of a methanol production industry employing renewable feedstocks can influence not only short term labour pools, but also the long term economic sustainability and health of many Northern communities. We have suggested that the creation of a methanol industry might have a beneficial impact on forest management practices, and that SO_2 and CO_2 emissions could be reduced substantially. We have suggested a method through which Northern Ontario residents might gain greater control over the development of their own region.

The technology for the production and utilization of methanol is currently understood, and is in place on a limited scale in several locations throughout the world. A concerted effort to harvest the surplus biomass in areas which have already been logged could provide sufficient fuel to allow the prople of the north liquid fuel self sufficiency, and could allow for shipping of excess fuels to southern markets, if desired.

Several issues will require continuing research and development prior to the development of a full scale methanol program. Some of these issues may well be within the terms of reference of The Royal Commission on the Northern

Environment. Our recommendations for further research and actions fall into four general categories.

(A) Technical:

1. The penetration of "neat" methanol fuels into Northern Ontario fleet operations, such as taxis, government vehicles, forest fleets, etc.
2. Increasing production levels to allow the use of methanol blend fuels in sourhern markets to a level of 7%.
3. The development and Northern Ontario penetration, by 1989, of "neat" fuel burning vehicles.

(B) Implementation:

1. The establishment of a steering committee with representation from all interested parties involved in the methanol process from feedstock procurement to fuel distribution.
2. The evolution of the steering committee into a Crown Corporation having extensive Northern Ontario representation on its Board of Directors.
3. The Crown Corporation would have a limited mandate (i.e. 5 - 7 years or until technical and economic viability is better established), after which gradual management and R & D efforts would be transferred to private sector operators.

(C) Feedstocks

1. The improvement of feedstock inventory techniques in order to better assess potential collection sites and plant locations.
2. More stringent legislation governing forest management and reforestation practices.
3. The use of methane hybrid production techniques in the short term, to be gradually replaced by renewable feedstocks alone in

the longer term, when economically and environmentally plausible.

4. Research on the viability of hybrid poplar as a Northern feedstock.

(D) Distribution and Marketing

1. The establishment of pricing and taxation policies at the pump to regulate the market penetration of methanol.
2. To conduct research on the most appropriate method of transporting methanol to southern markets (Pipeline, tanker, rail car, etc.)

Methanol production in Northern Ontario presents numerous opportunities for the careful development of the region, with benefits extending to improved forest management, direct and indirect employment, and increasing control of the north by the people of the north. Methanol will require explicit policy recommendations, and in some cases, explicit revisions to existing tax and regulatory structures. However, the benefits of such reform could be enormous.

BIBLIOGRAPHY

Three Main Reports

InterGroup Consulting Economists Ltd., Liquid Fuels from Renewable Resources: Feasibility Study, prepared for the Interdepartmental Sttering Committee on Canadian Renewalbe Liquid Fuels, Fisheries and Environment Services, Ottawa. (1978). VI volumes:

- Summary and Conclusions
- Demand Studies
- Conversion Studies
- Forest Studies
- Agricultural Studies
- Municipal Studies.

Symposium on "Alcohols as Alternative Fuels for Ontario", held in Toronto, November 19, 1976. Sponsored by the Ontario Ministry of Energy.

- Azarniouk, M.R., & Thompson, R.M., "Alcohol from Cellulose - Production Technology".
- Bern, Lars, & Branberg, A., "Methanol Supply to a Swedish Motor Fuel Market", Swedish Methanol Development Co., Stockholm.
- Fischer, D.A., "Shell's Field & Laboratory Experience in the Use of Alcohols".
- Maasland, D.E.L., "Potential Impact of Widespread Use of Alcohol Produced from Forest Biomass".
- Moll, A.J. & Clark, C.F., "An Overview of Alcohol Production Routes".
- Reed, Dr. I.B., "Potential Impact of Widespread Use of Wood & Alcohol: Questions and Issues".
- Shell Canada, "Use of Methanol and other Alcohols as Fuels".
- Tillman, R.M., "Blending Distribution & Marketing Aspects of Alcohol as Alternative Fuels".
- Timbers, G.E., "Alcohols from Cellulose - Agricultural Resources."

Report of the Advisory Group on Synthetic Liquid Fuels of the Ontario Ministry of Energy, Liquid Fuels in Ontario's Future: Findings and Recommendations, Ministry of Energy, Toronto, 1979.

Reference Reports prepared for consideration by the Advisory Group:

- An Economic Analysis of Snythetic Liquid Fuels, Canadian Resourcecon Ltd.
- Candidate Raw Materials for the Production of Synthetic Liquid Fuels, Raw Materials Task Force.
- The Production of Synthetic Liquid Fuels for Ontario, Chemical Engineering Research Consultants Ltd.
- Utilization of Methanol-Based Fuels in Transportation, Ontario Ministry of Transportation and Communications.
- Utilization of Methanol in Stationary Source Combustion, Canadian Combustion Research Laboratory.
- Utilization of Synthetic Liquid Fuels for Electric Generation, Ontario Hydro.

Armson,K.A.: Forest Management in Ontario
Ministry of Natural Resources, Toronto , 1976

Bene, J.G.,Beall, H.W., Marshall , H.B.: Energy from Biomass for Developing Countries
International Development Research Centre,
Ottawa , 1978

Bohlen, JC.; Fuel-Wood; Canada's Renewable Energy Resource
Submission to Science Council,Ottawa, 1972

Canadian Association in Support of Native Peoples; For Generations Yet Unborn
The Bulletin , Toronto, 1977

Carlisle, A : The Utilization of Forest biomass and forest industry Waste for the Production and Conservation of Energy.
Department of the Environment, Ottawa,1976

InterGroup Consulting Economists Ltd: Economic pre-Feasibility Study; Large Scale Methano Fuel Production from Surplus Canadian forest biomass
Fisheries and Environment, Ottaw ,1976

Levelton, B.H. An Evaluation of Wood Wast Conversion Systems
Western Forest Research Lab., Environment Canada ,1978

Love , . , and Overend ,R. : Tree Power
Energy Mines and Resources, Ottawa , 1977

MacKay D. and Sutherland R. : Methanol in Ontario
Ministry of Energy, Toronto, 1976

Marshal J. E. et al : A Look at the Economic Feasibility of Converting Wood into Liquid Fuel,Environment Canada 1975

Reed F.L.C. : Forest Management in Canada Vol. I and II,
Environment Canada , 1978

SNC Consultants; Hearst Woodwastes Energy Study, Ontario Ministry of Energy,
Toronto, 1977

Steenberg, B.K.: The Northern Coniferous Forest, A Primary Source of World Resources, Speech to Ontario Professional Foresters Association, 1976

---: Canadian Forestry Statistics, 1976, Statistics Canada, 1978

---: Canadian Natural Gas Supply and Requirements, National Energy Board,
1979

---: Proceedings of a Symposium on Economics of Renewable Energy and Energy Conservation Options, Biomass Energy Institute, 1978

---: The Forest Industry in the Economy of Ontario, Ministry of Natural Resources,
Toronto, 1977

---: Submission to the Ontario Royal Commission on Electric Power Planning, Fisheries and Environment Canada, Ottawa, 1976

---: Federal-Provincial Consultations on the Economy; Forestry Ministers -- Government of Canada, January, 1978